

PRK
Complication

S

Classification

- Early (<6 weeks)
- Early or Late
- Late (>6 weeks)
- Refractive
- Miscellaneous

Early

- Pain
- Sterile infiltrates
- Immune cells
- Infectious keratitis
- Delayed epithelialization
- Contact lens-related issues
- Pseudodendrites



Pain

- Intensity variable
 - FBS, “sand,” “eyelash”
 - “Broken contact lens”
 - “Knives, rocks, bricks”
 - Ache
 - “Broken bottle filled with suntan lotion”
- Related to epithelial defect
- Lasts 24-48 hours
- Treatment
 - Topical NSAIDS
 - Topical Tetracaine
 - Cooled Celluvisc
 - TSCL
 - Oral pain medication
 - Cool compresses

Sterile Infiltrates

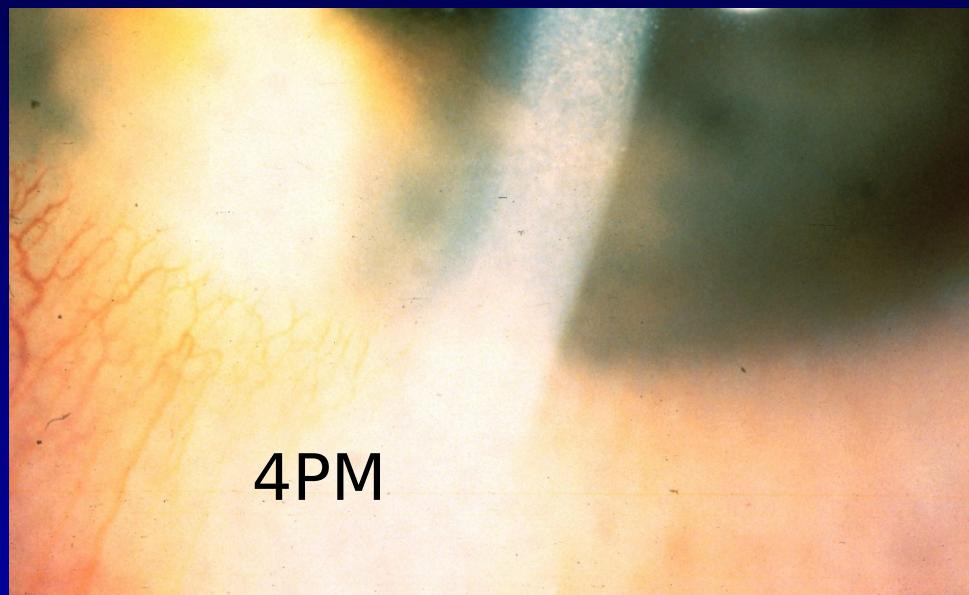
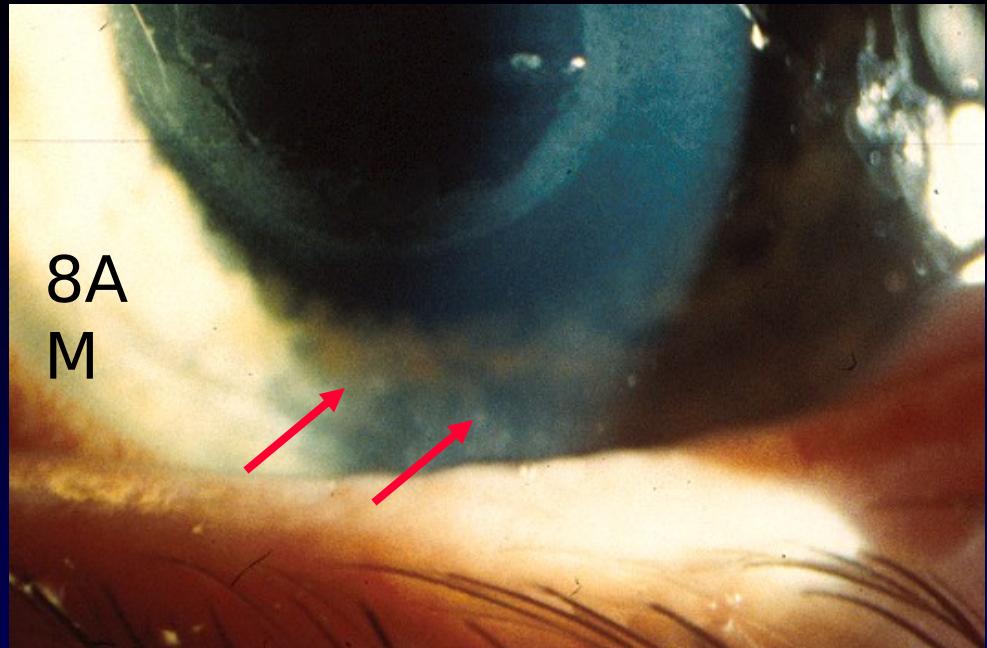
- Frequency 1:300-1:500
- Focal opacities
- Usually multiple
- Associated with immune cells
- May be outside ablation zone
- Be wary for true infectious keratitis

- Treatment
 - Stop NSAIDS
 - Start or increase steroids
 - Antibiotic coverage
 - Monitor closely
 - Very low threshold to culture

USAF PRK Study

Sterile Infiltrates

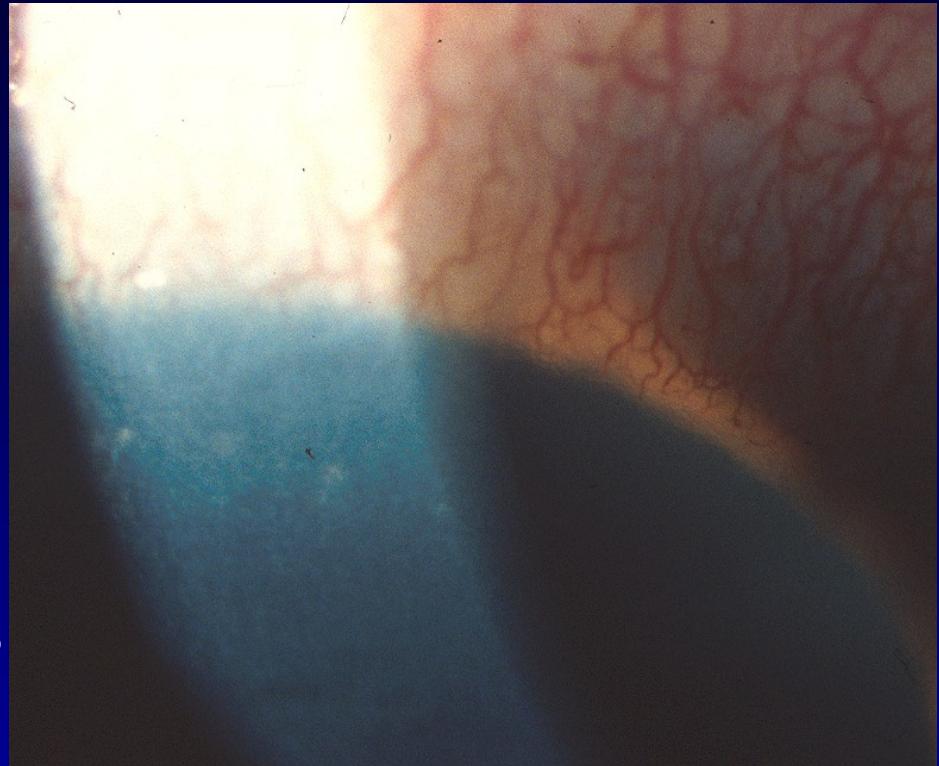
- 2 of 139 eyes (2%)
- Onset POD1 in both eyes
- Different patients
- Both eyes had concurrent immune cells
- Resolution by POD7 for both eyes
- One eye lost CL before POD1 exam



USAF PRK Study

Stromal Immune Cells

- Present in 47% (40/86) eyes for which data collected
- Onset (eyes):
 - POD1 32% (13/40)
 - POD2 38% (15/40)
 - POD3 28% (11/40)
 - POD4 0 (0/40)
 - POD7 2% (1/40)
- Duration > 7 days: 17% (6/35)



USAF PRK Study

Stromal Immune Cell Location

- Peripheral cornea 95% (38/40)
 - Superior quadrant alone 71% (27/38)
 - Superior quadrant +/- other quadrants **92%** (35/38)
 - Other quadrants alone 8% (3/38)
 - All quadrants (360 degrees) 5% (2/38)
- Central cornea 2% (1/40)
- Complete cornea 2% (1/40)

Infectious Keratitis

- Frequency unknown
- Corneal infiltrate
- Overlying epithelial defect
- Usually unifocal, can be multiple
- Often within the ablation zone
- Treatment
 - Culture
 - Some recommend topical ofloxacin or ciprofloxacin q hour if small lesion
 - Consider fortified antibiotics q hour
 - > Cefazolin 50mg/ml
 - > Tobramycin 15mg/ml
 - Consider cycloplegia



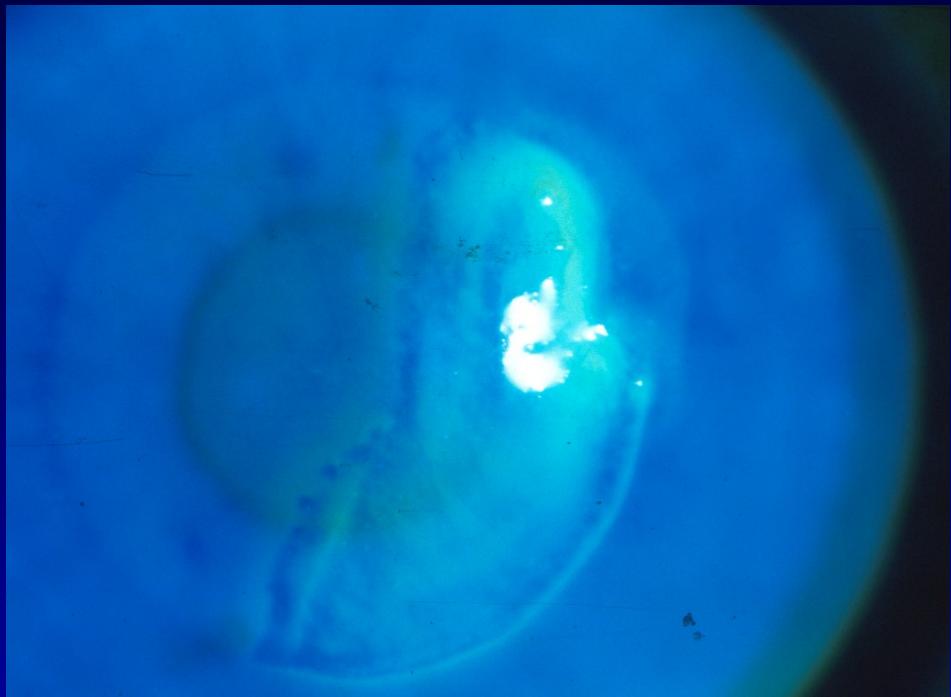
USAF PRK Study

Infectious Keratitis

- Culture positive
 - 0% (0/139) eyes
- Presumed (culture negative)
 - 1 eye (1/139; 0.72%)
 - › Onset POD3, 0.3 mm, outside ablation zone
 - › Fortified antibiotics
 - › Resolved in 24 hours
 - › At 6 months: UCVA 20/13, BCVA 20/10

Delayed Epithelializatio n (>4days)

- Frequency 0-2%



- Associated with
 - Early TSCL removal
 - Poor TSCL fit
 - Debris under TSCL
 - Epithelial flap
 - Patient predisposition (ocular surface or systemic)
- Treatment
 - Add or exchange TSCL
 - Increase lubrication
 - Continue antibiotic
 - Stop NSAIDS
 - Punctal occlusion
 - Consider topical anesthetic abuse, HSV, infectious keratitis

USAF PRK Study

Epithelialization

- 100% of eyes epithelialized by day 4 (n=139)
- Time to epithelialization (eyes)

- 1 day	0	(0/139)
- 2 days	45%	(63/139)
- 3 days	53%	(73/139)
- 4 days	2%	(3/139)
- <i>Mean</i>	<i>2.6 days</i>	(139/139)
- Delayed epithelialization > 4 days: 0%

USAF PRK Study

Contact Lens (CL) -Related Issues

- 100% of eyes given CL day of surgery
- Time to CL removal (eyes):

- 1 day	0	(0/135)
- 2 days	33%	(45/135)
- 3 days	62%	(84/135)
- 4 days	4%	(5/135)
- 5 days	1%	(1/135)
- <i>Mean</i>	<i>2.7 days</i>	(135/135)

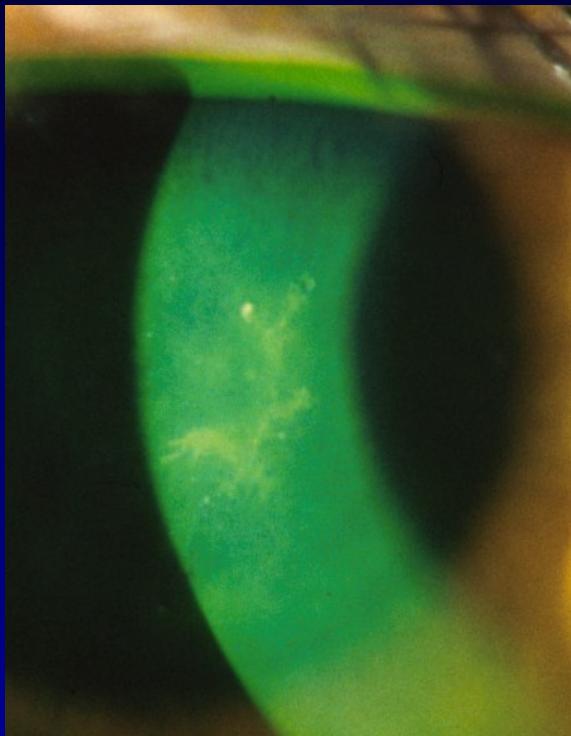
USAF PRK Study

Contact Lens (CL) -Related Issues

- 11.1% (15/139) of eyes lost a CL
- 3% (4/139) eyes required CL replacement POD1-2 for better fit
- 4% (6/139) developed recurrent epithelial defect following CL removal
 - 7% (3/45) eyes with CL removed POD2
 - 4% (3/84) eyes with CL removed POD3

Pseudodendrites

- Common in 1st week
- Normal healing response
- Treatment
 - Observation
 - No change in medications
- Consider HSV if
 - occurs after epithelium has healed
 - is associated with intraocular inflammation



Early or Late

- Ocular hypertension
- Loss of BCVA
- Halos
- Central islands
- Decentration
- Recurrent corneal erosion

Ocular Hypertension

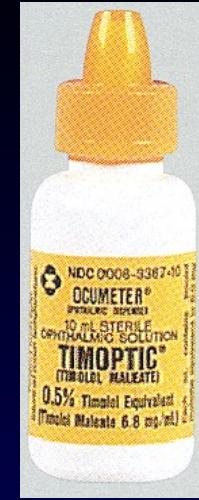
- Ta > 25
- Topical steroid-related
- 30% population steroid responsive
- 0.8-32*% post PRK
- IOP monitoring essential (monthly)
- Treatment
 - Timolol (Timoptic)
 - Brimonidine (Alphagan)
 - Dorzolamide (Trusopt)
 - Neptazane
 - Acetazolamide (Diamox)
- Do not independently stop steroids

**8-10mm rise*

USAF PRK Study

Ocular hypertension ($T_a \geq 25$ mm)

- 14% of eyes (19/139)
 - 11 patients, 19 eyes
 - 3 patients had unilateral OHT only
- Onset: week 2-8, mean 4.5
- Range of intraocular pressure: 25-38 mm, mean 29
- Treatment
 - None 0% (0/19)
 - 1 agent 74% (14/19)
 - 2 agents 16% (3/19)
 - 3 agents 5% (1/19)
- Resolution off steroids in all eyes



Loss of BCVA

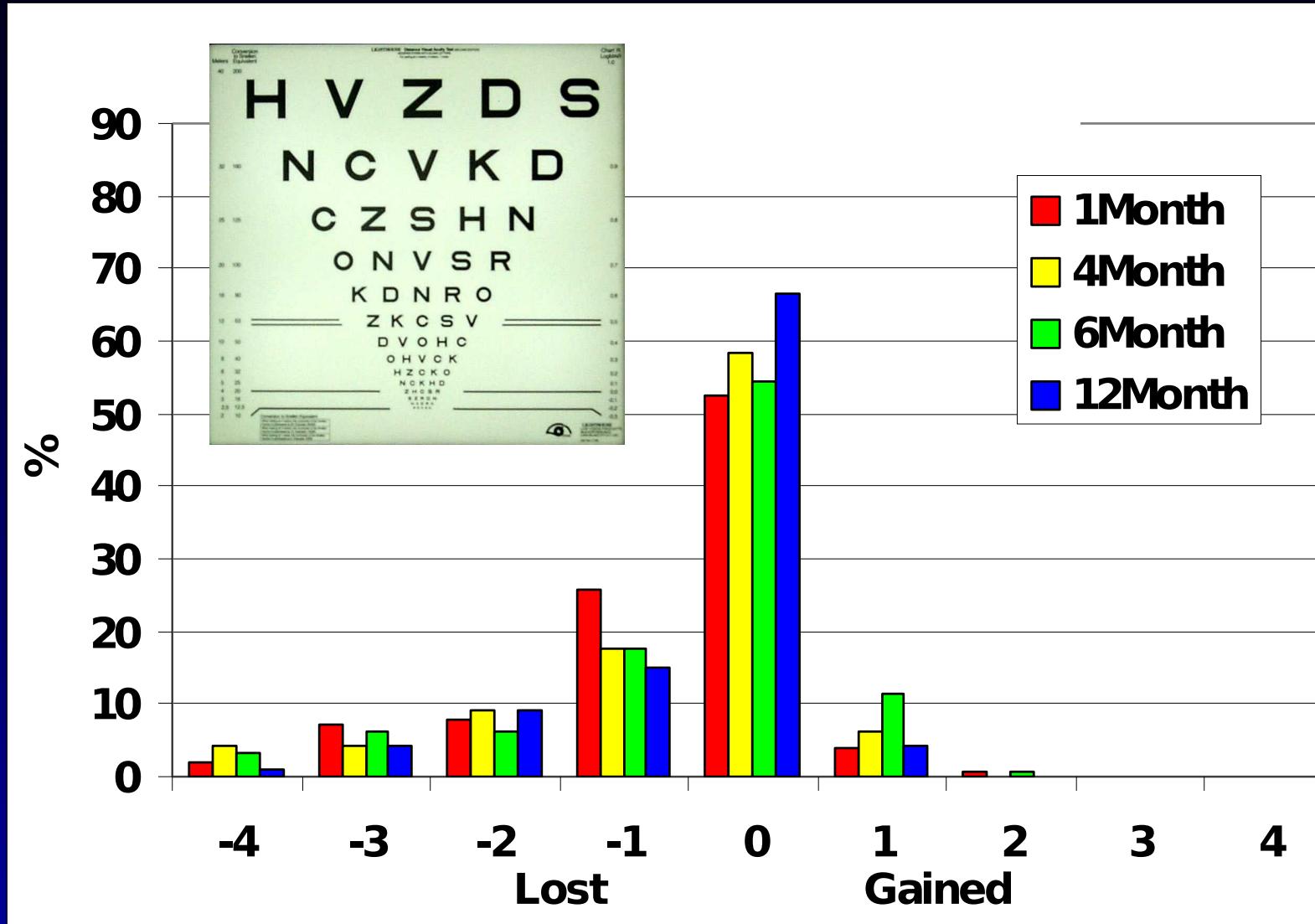
- Usually early
- Uncommon late
- Causes
 - Epithelial irregularity
 - Haze
 - Irregular astigmatism
 - Central islands
 - Decentered ablation
 - Non-PRK cause
- Evaluation
 - Full eye exam
 - › R/O retinal pathology
 - Topography
 - HCL overrefraction
 - PAM
 - Treat underlying cause as needed

USAF PRK Study: BCVA Lines Lost (%)

Lines Lost	1Month	4Month	6Month	12Month	24Month
-4	0.0	0.0	0.0	0.0	0.0
-3	0.7	0.0	0.0	0.0	0.0
-2	2.6	0.7	1.4	0.0	0.0
-1	13.2	6.3	4.1	5.0	2.4
0	75.0	80.3	68.7	74.8	66.7
1	7.9	12.7	24.5	18.5	28.6
2	0.7	0.0	1.4	1.7	2.4
3	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0
Total%	100.0	100.0	100.0	100.0	100.0
n	152	142	147	119	42

* Line lost at 24 months was 20/12 to 20/15

USAF PRK Study: UCVA vs. BSCVA Lines Lost and Gained, ETDRS

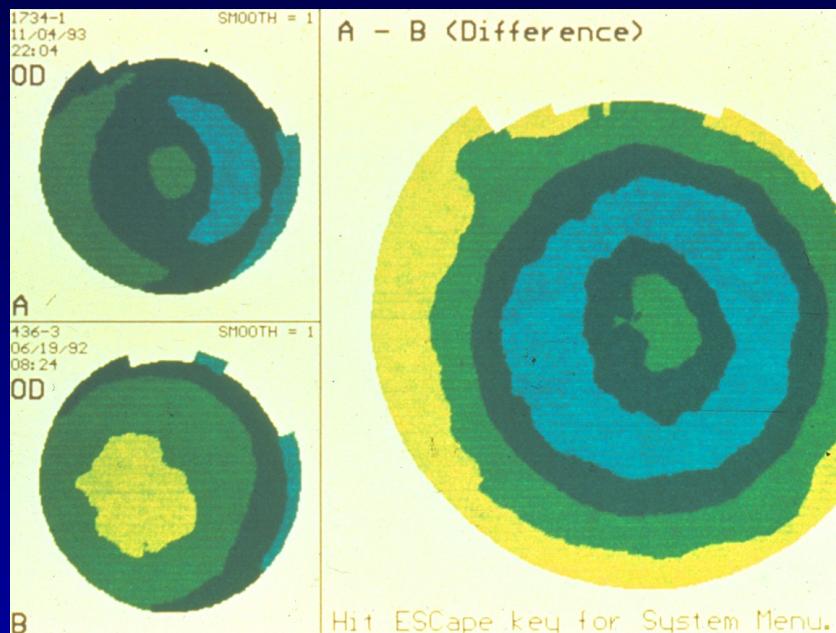


Halos

- Common early
- Uncommon late
- Causes
 - Epithelial abnormalities
 - Residual refractive error
 - Large pupil
 - Central islands
 - Decentered ablation
 - Astigmatic ablations
- Treatment
 - Depend on cause
 - Improve/ resolve in most patients with time
 - If pupil related consider
 - › Dapiprazole
 - › Pilocarpine (careful)

Central Islands

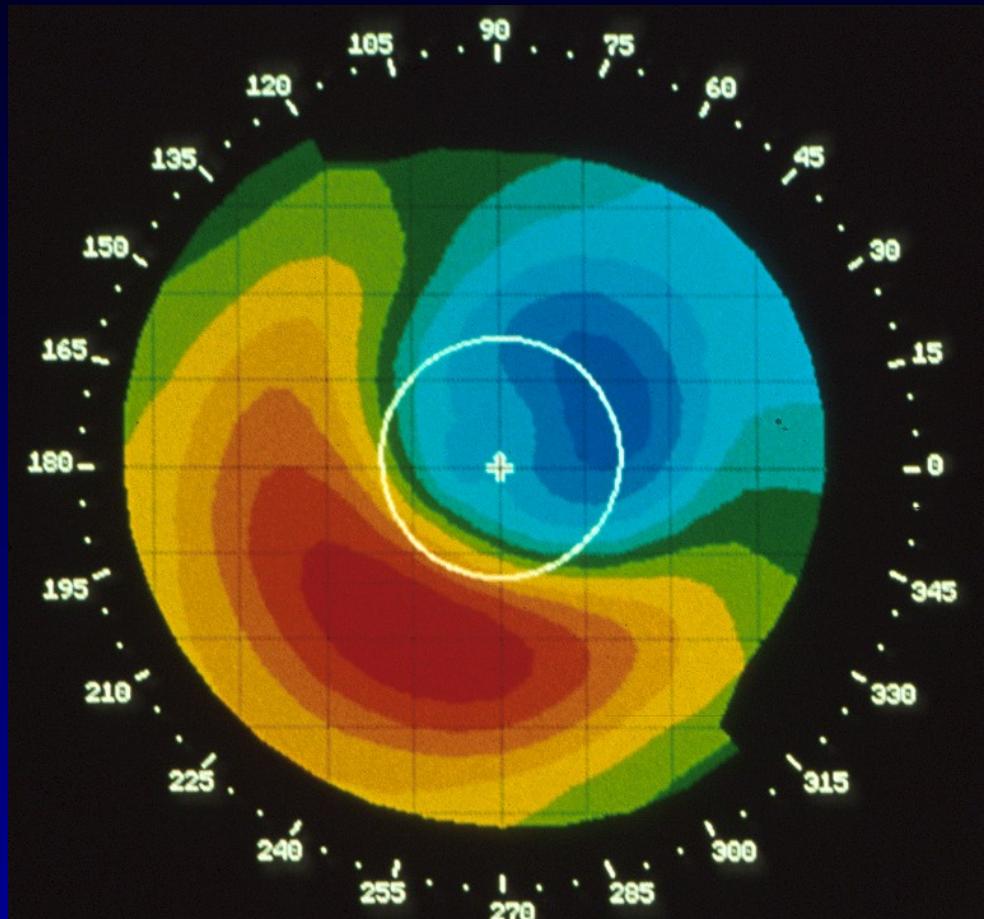
- Central elevation by SUBTRACTION MAP
- No uniform definition
- Uncommon



- Causes
 - Fluid wave
 - Plume obstruction
 - Laser optics
 - Epithelial hyperplasia
 - Other
- Treatment
 - Most resolve in time
 - PTK

Decentered Ablation

- Decentration of > 1mm by SUBTRACTION MAP *at 1 month*
- Asymmetric healing can make centered ablation appear decentered
- Loss of BCVA, glare, halos, diplopia, etc..



EyeSys

Decentered Ablation

- Causes
 - Laser misalignment
 - Poor patient fixation
 - Surgical decentration
 - Movement/misalignment during videokeratography
- Treatment
 - Several
 - › Retreatment with equal and opposite decentration
 - › Occlusive masks
 - › Others
 - None ideal
 - Await future technology
 - › Custom ablations
 - › Wavefront ablations

Miotics decenter pupil

Recurrent Erosion

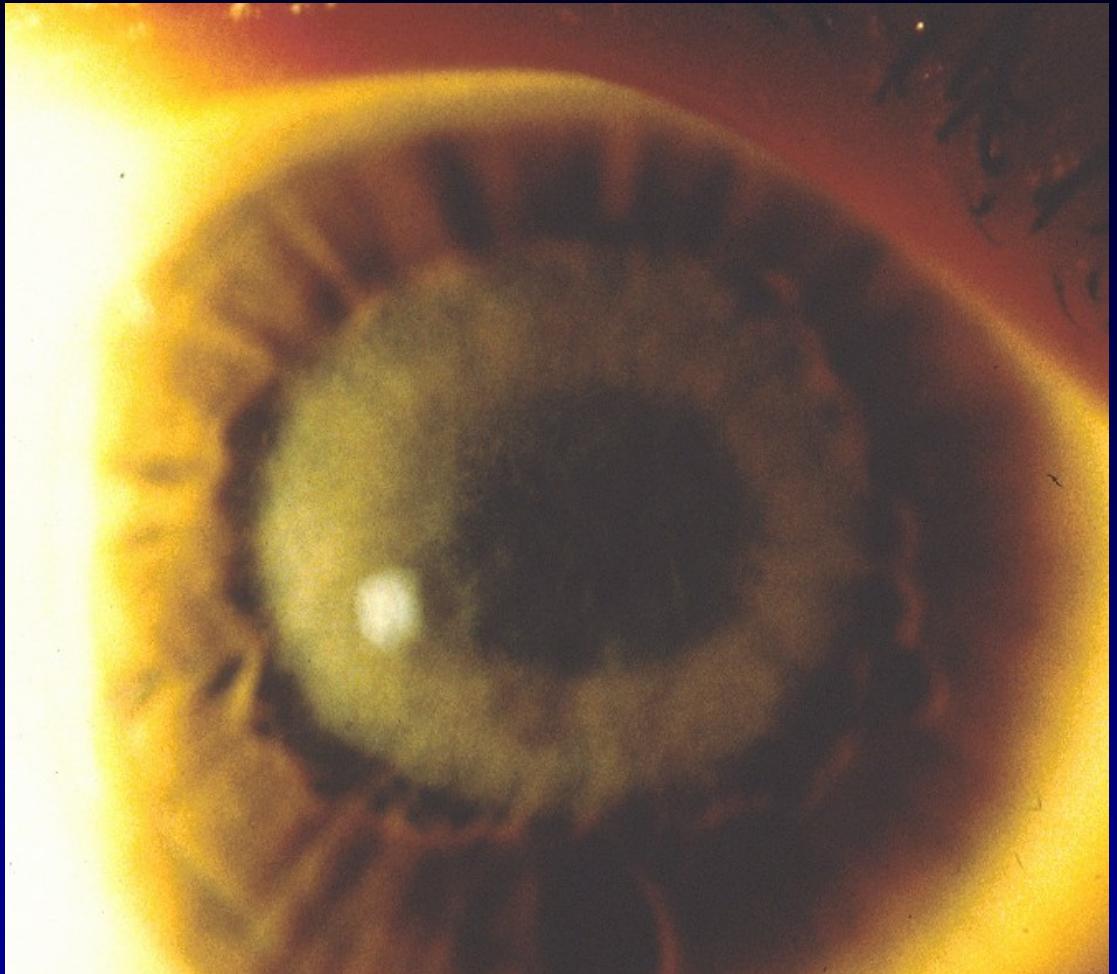
- Pain, FBS, tearing
- Decreased vision
- Usually upon awakening
- Epithelial defect or microcysts
- Rare after PRK
- Likely due to underlying predisposition and outside ablation zone
- Treatment
 - Antibiotics until epithelialized
 - Lubricants
 - TSCL
 - Hypertonic saline
 - PTK/ PRK
 - Stromal puncture

Subjective Dry Eyes

- Common early
- Uncommon late
- Treatment
 - Lubricants
 - Punctal occlusion
 - Manage blepharitis

Late

- Haze
 - Early onset
 - Late onset
corneal haze
(LOCH)

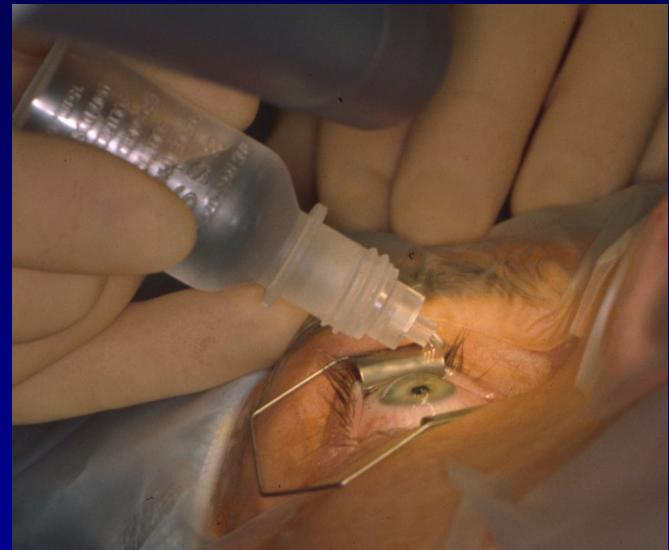


Haze

- Early onset occurs in 1st 3-6 months, then typically resolves
- LOCH occurs 4-33 months post-op
- Most asymptomatic
- Can have loss of BCVA, visual symptoms
- Central haze may be associated with regression
- Peripheral haze may be associated with astigmatism or overcorrection

Haze

- Potential causes
 - UVB exposure
 - Deeper ablations
 - Laser beam homogeneity
 - Epithelial removal technique
 - K sicca
 - Keloid formation (?)
 - Rapid steroid taper (?)
- Prevention
 - Patient selection
 - Cold BSS irrigation
 - Sunglasses



Haze Grading

Stein, The Excimer: Fundamentals and Clinical Use,
SLACK, 1997

- **Trace:** trace of faint haze by indirect broad oblique illumination
- **Mild:** discrete haze visible with difficulty by direct focal slit examination. More granular and confluent than trace.
- **Moderate:** moderately dense corneal opacity that obscures iris detail in direct illumination
- **Severe:** a severely dense opacity that completely obscures iris detail

Haze Grading

McDonald *et al.*, *Ophthalmology* 1991;98:1327

- 0: clear cornea
- **Trace:** barely perceptible haze apparent only to trained observer
- 1.0: mild reticular haze not affecting refraction
- 2.0: moderate haze, refraction possible but difficult
- 3.0: opacity prevents refraction, anterior chamber easily viewed
- 4.0: opacity impairs view of anterior chamber and iris detail
- 5.0: totally opaque scar, anterior chamber not visible

Haze Grading

Braunstein *et al.*, *Ophthalmology* 1996;103:439

- 0: clear, no haze
- 0.5: haze, barely detectable
- 1.0: mild, not affecting refraction
- 1.5: haze mildly affecting refraction
- 2.0: moderate haze, refraction possible but difficult
- 3.0: opacity prevents refraction, anterior chamber easily viewed
- 4.0: opacity impairs view of anterior chamber
- 5.0: unable to see anterior chamber

USAF PRK Study

- Early Onset Haze: ($\geq 2+$, <6 months)
 - Moderate, refraction difficult
 - 0% (0/139) eyes
- Late Onset Corneal Haze: (any, >6 months)
 - 6.6% (5/76) eyes
 - › worst UCVA 20/20
 - › worst BCVA 20/15

Haze Treatment

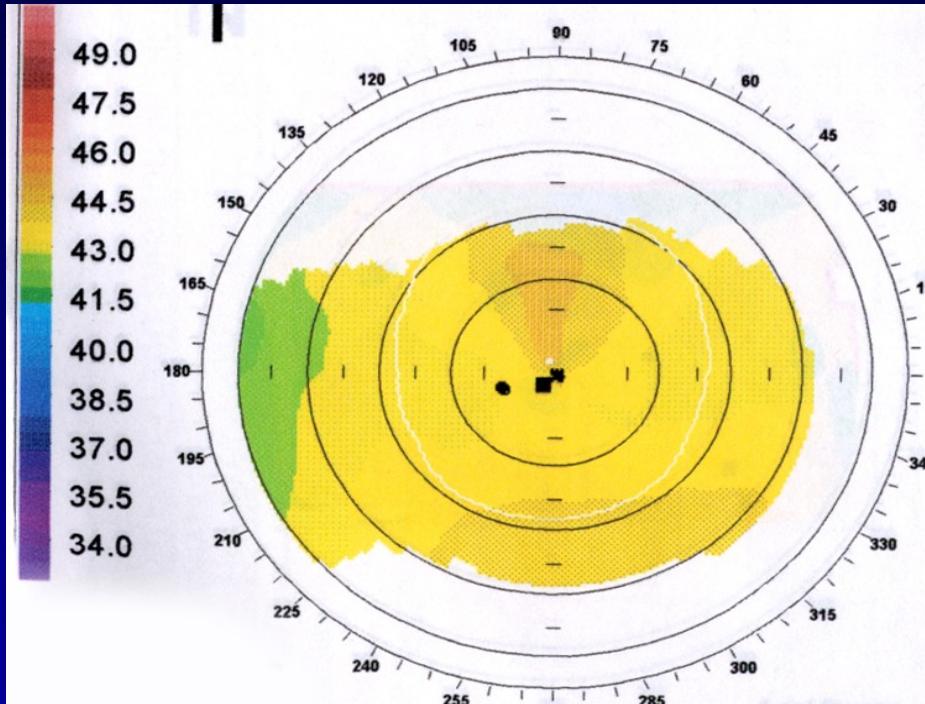
- Early Haze
 - Ensure patient following prescribed steroid taper
 - Observation
- LOCH
 - Observation
 - Topical steroids
 - PTK
 - MMC

MOST HAZE RESOLVES WITH TIME

PATIENT: PRK OU 4/01

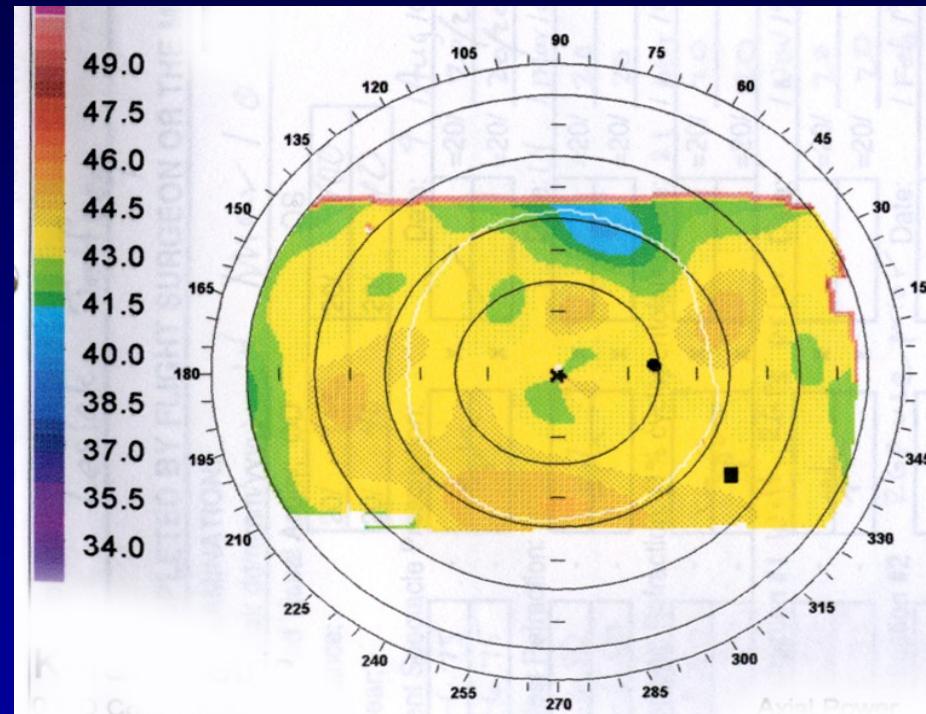
OD

- -6.50 OD
- Orbscan Pach 565
- VISX S2
- Laser scrape
- Tx depth 80



OS

- -6.75
- Orbscan Pach 570
- VISX S2
- Laser scrape
- Tx depth 80



Postop Course

- **1 Week:** UCVA 20/20 OU
 - $-0.25 + 0.25 \times 108$
 - $-0.50 + 0.75 \times 066$
- **1 Month:** UCVA 20/20; 20/25
 - PI + 0.50×070 (20/20)
 - $+0.50 + 0.25 \times 66$ (20/20)
- **2 Months:** UCVA 20/20 OU
 - PI + 0.25×068 (20/20+)
 - $+0.50 + 0.75 \times 038$ (20/15)
- **3 Months:** UCVA Missed

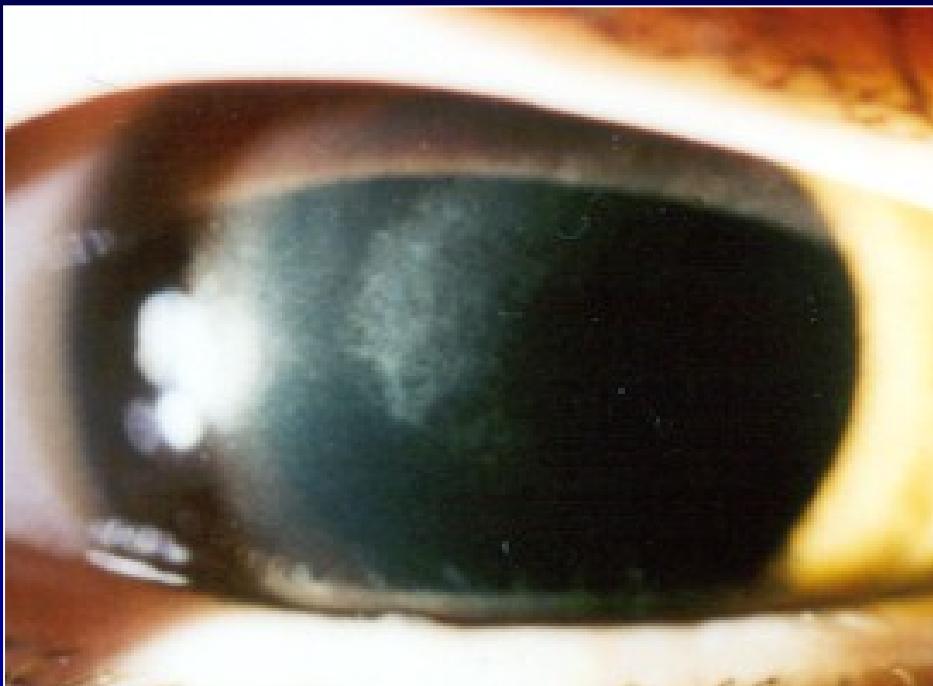
Postop Course

- **4 Months:** UCVA 20/20 OU
 - Plano OU (20/20 OU)
 - Faint peripheral haze OU
- **7 Months:** UCVA 20/20 OU
 - -0.50 OU (20/20)
 - Grade 3 haze OU
- **7.5 Months:** UCVA 20/20 OU
 - Plano (20/20) Grade 1 haze
 - Pl -0.75 x 80 (20/20) Grade 2 haze

PRK OU 10 Months

OD

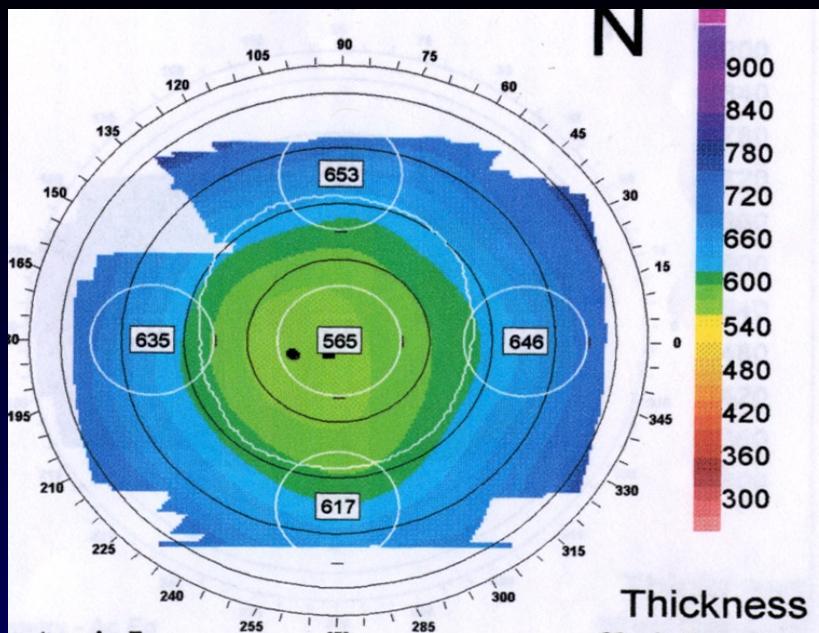
- UCVA 20/30
- BCVA 20/16
- Cyc + 0.50 + 0.50 x 045
- Orbscan Pach 355



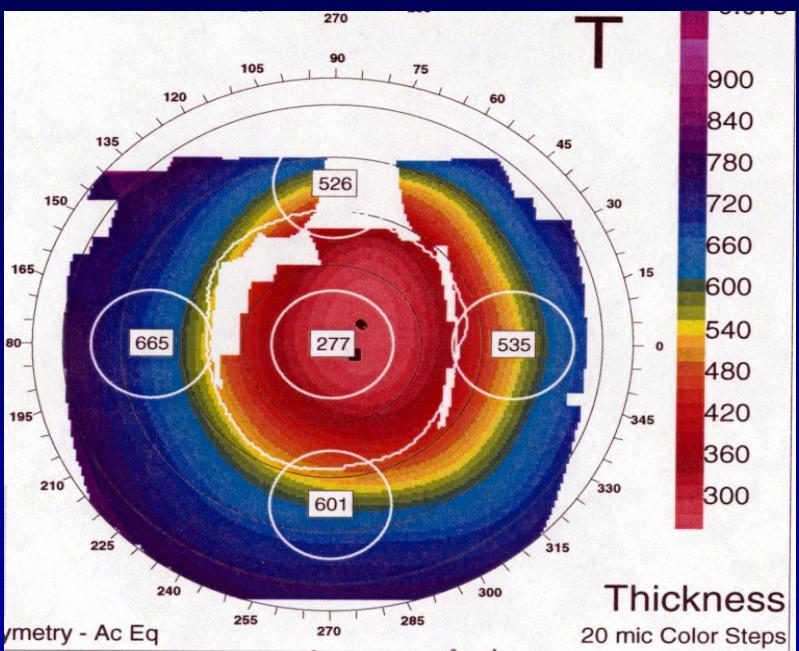
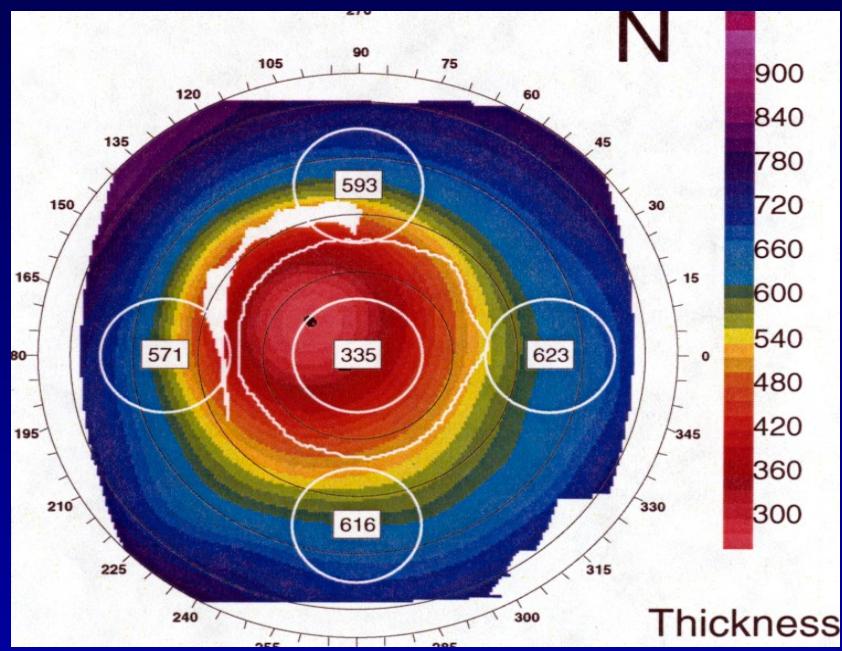
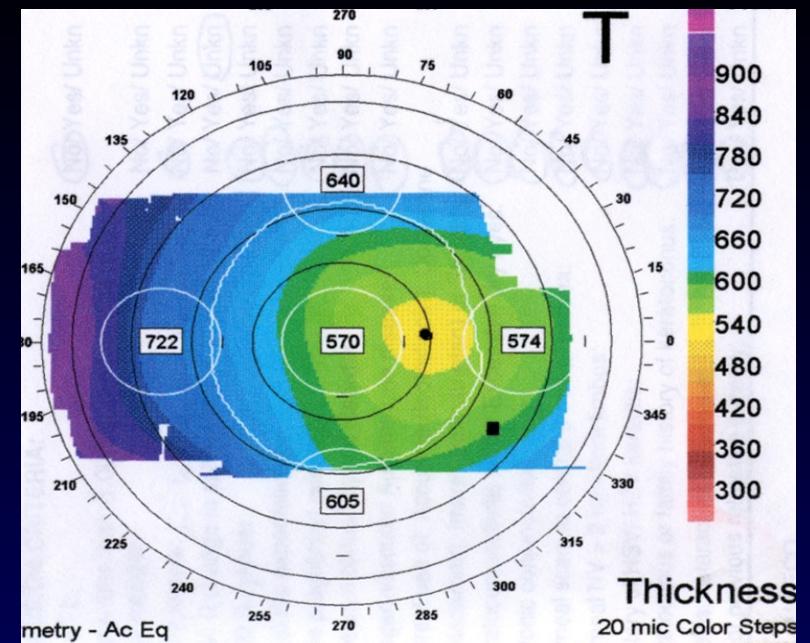
OS

- UCVA 20/200
- BCVA 20/28
- Cyc -2.50 + 0.25 x 050
- Orbscan Pach 277





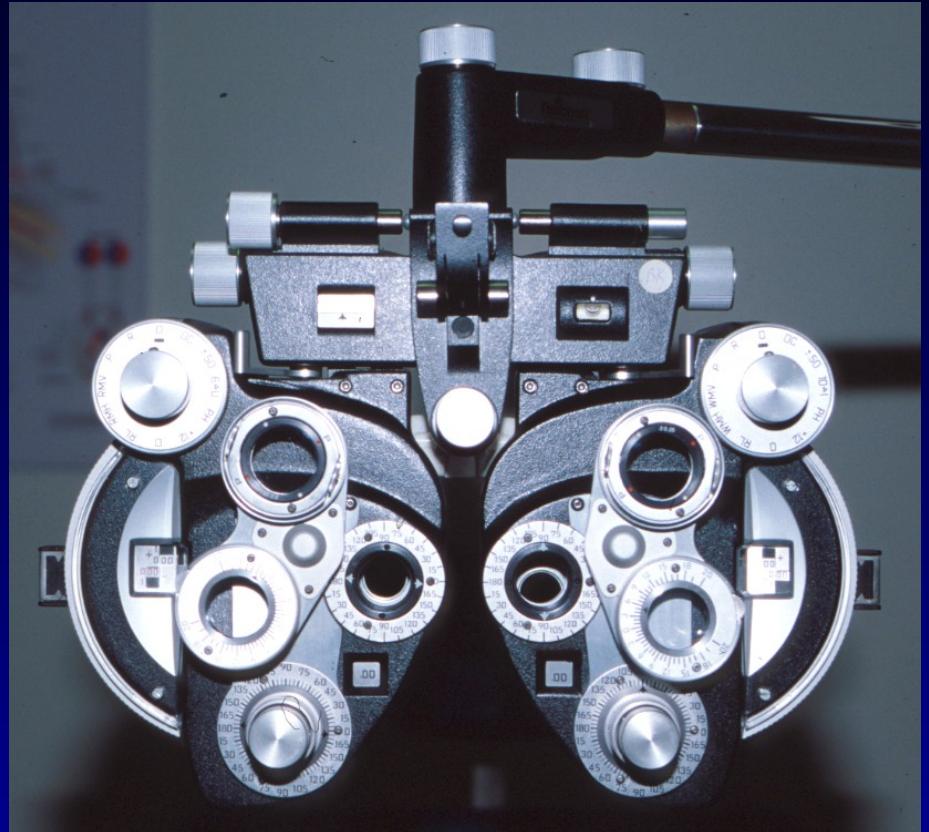
10
Months



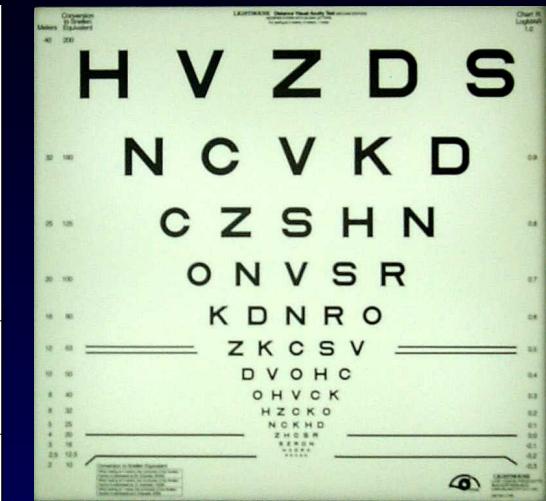
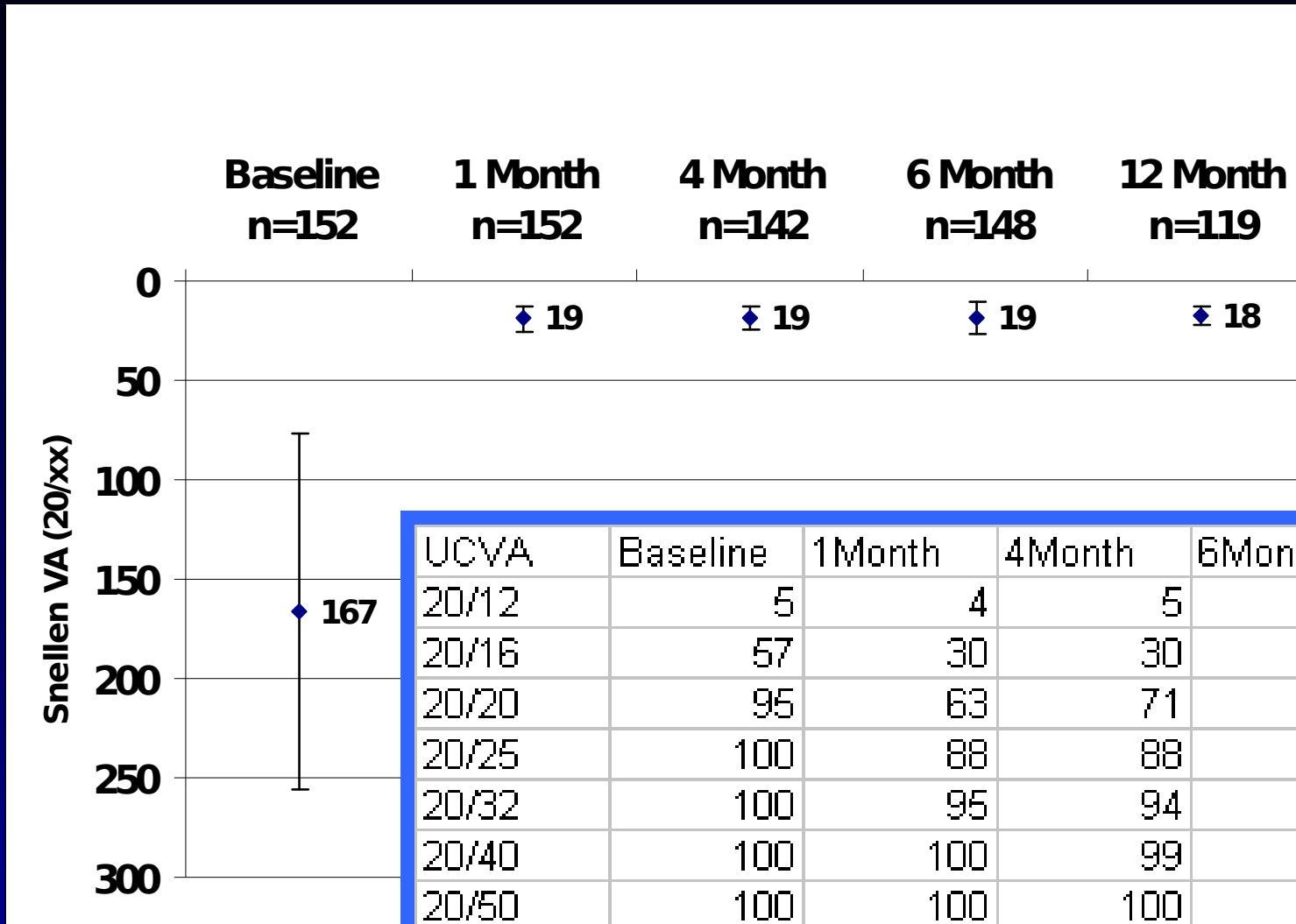
DGH
498

Refractive

- Level of UCVA
- Primary Undercorrection
- Overcorrection
- Presbyopia
- Regression



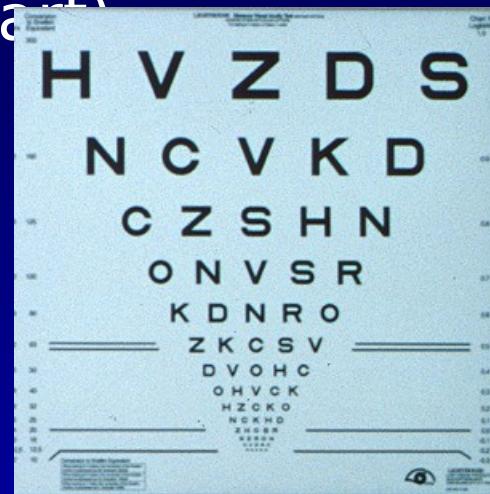
USAF PRK Study: UCVA, ETDRS



n (24 mos) = 42

Undercorrection

- >1 D deviation from intended correction at 3-6 mos post-op
- Compare cycloplegic refractions
- Haze increases refractive myopia and refractive uncertainty
- Causes
 - Undertreatment
 - Wet cornea
 - Aggressive healer
 - Rapid steroid taper
 - Haze
- Treatment
 - Some myopia is good for peri-presbyopes
 - Consider retreatment
 - Ensure refractive stability (+/- 0.5 D over 3 refractions, 1 mo apart)



Overcorrection

- Common early
- Expect about 0.5 D myopic shift in first 6 mos



- Causes
 - Poor pre-op cycloplegic refraction
 - Incorrect treatment parameters
 - Dry cornea during treatment
 - Thin epithelium post-op

Overcorrection

- Treatment
 - If persists after 1 month, hasten steroid taper, monitor closely for haze
 - Lubricants
 - TSCL
 - Epithelial debridement
 - Hyperopic PRK when stable

USAF PRK Study: Cycloplegic Refraction

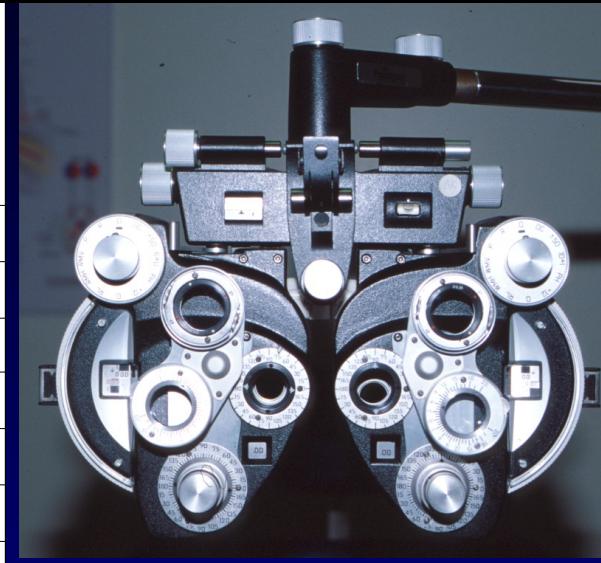
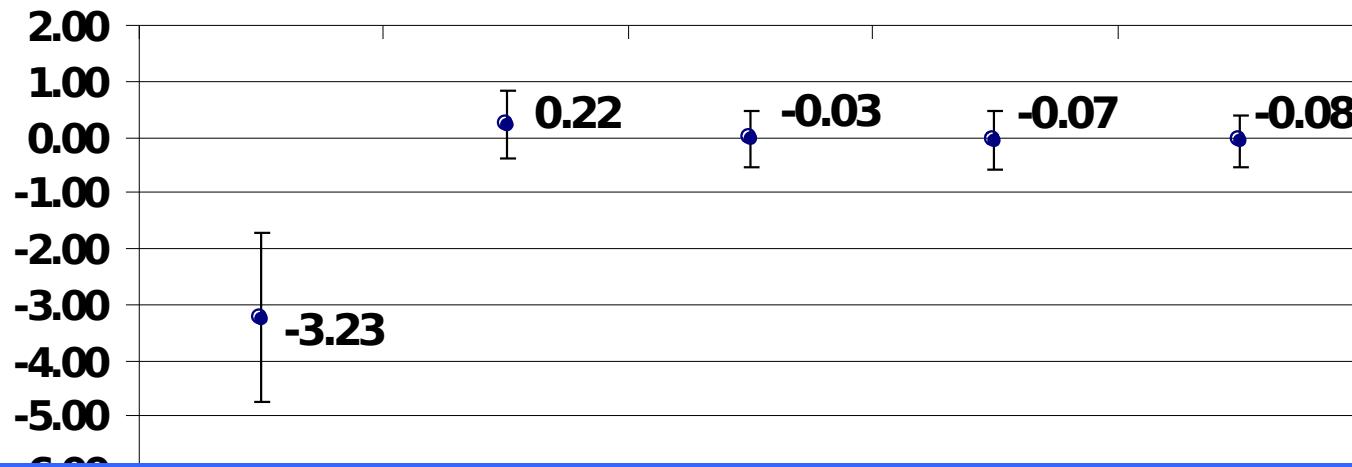
Baseline
n=151

1 Month
n=151

4 Month
n=142

6 Month
n=144

12 Month
n=113



n (24 mos)= 40

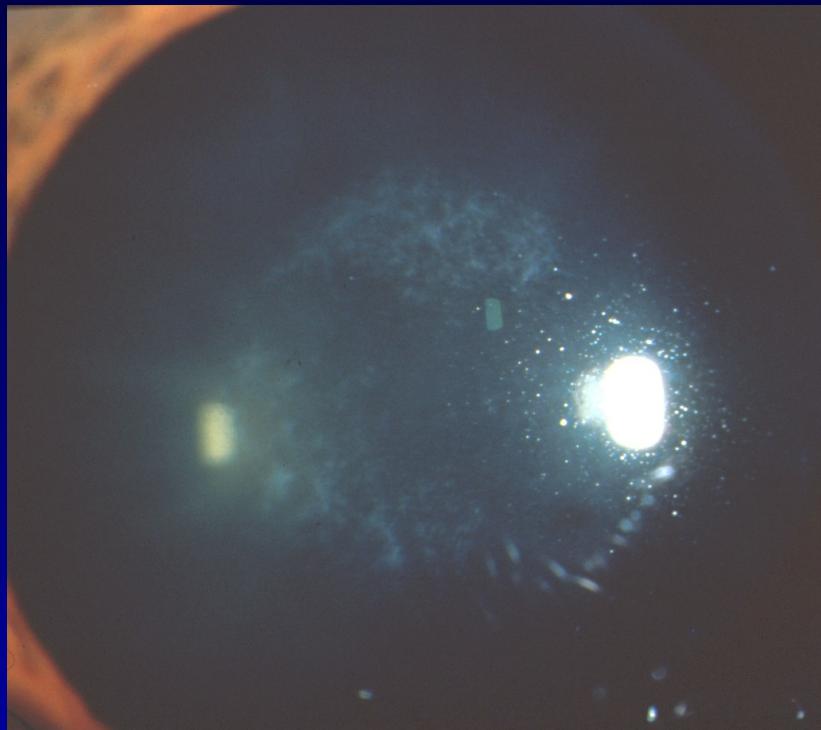
	1 Month	4 Months	6 Months	12 Months	24 Months
+/- 0.25	38.4%	46.5%	47.9%	54.0%	62.5%
+/- 0.5	64.9%	73.9%	72.2%	77.0%	87.5%
+/- 1.0	90.7%	97.9%	95.1%	98.2%	100.0%
+/-2.0	100.0%	100.0%	100.0%	100.0%	100.0%

Presbyopia

- NO MATTER HOW MANY TIMES PRE-PRESBYOPES ARE TOLD ABOUT THE POTENTIAL FOR READING GLASSES POST-OP, MANY DO NOT (OR CHOOSE NOT TO) UNDERSTAND
- *“I didn’t realize that I wouldn’t be able to read the can labels at the grocery store”*
- Emphasize, describe, and document preoperatively

Regression

- > 1 Diopter deviation from intended correction at > 6 mos post-op
- May be associated with haze



- Risk factors
 - UV exposure (OR 7.7*)
 - Rapid steroid taper
 - Steep wound edges
 - High myopia
 - Small optical zones
 - BCP (OR 13.5*)

*Corbett *et al*,
Ophthalmology 103:1381

Regression

- Treatment
 - Prednisolone acetate 1% qid for 2 weeks
 - › If refraction responsive, taper slowly (q 2 mos)
 - › If refraction not responsive, taper rapidly, monitor for haze, consider retreatment
- Retreatment
 - Only when refraction stable (+/- 0.5 D over 3 refractions, one month apart)

Miscellaneous Issues

Pregnancy

- Issues
 - Unreliable refractions
 - Dry eyes
 - Medication toxicity
- USAF PRK Study
 - Pregnancy: **1.4%** (1/71)
 - › 3 mos post second eye
 - › Removed from study
 - › UCVA 20/20 OU (24mos OD and 21mos OS)
 - › No haze

Eye Sensitivity

- Tenderness
- Photophobia
- Rare
- Typically resolve in time

USAF PRK Study

Miscellaneous Complications

- Basement membrane changes: 5% (7/139 eyes)
- Aborted treatment: 0.72% (1/139 eyes)
- Nausea from anisometropia requiring prochlorperazine (Compazine): 0.72% (1/139 eyes)

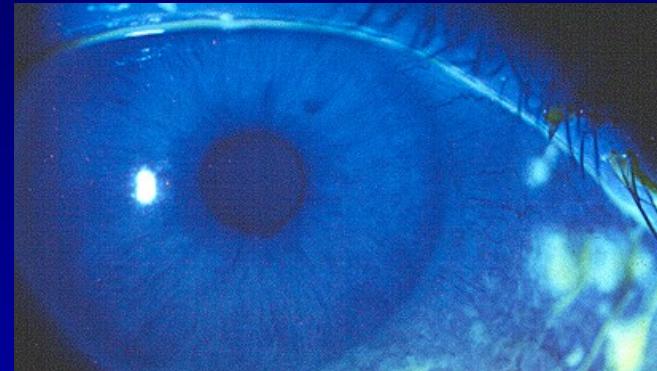
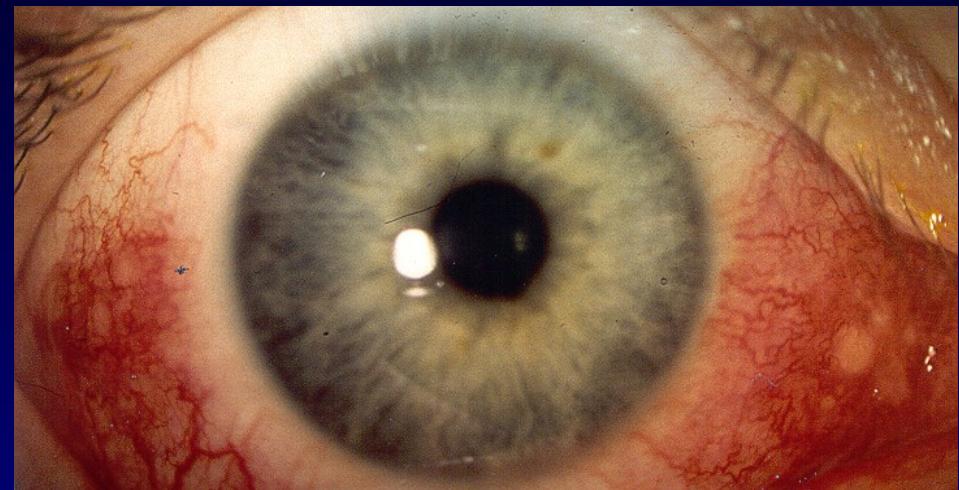
USAF PRK Study

Miscellaneous Events

- Ocular trauma: **7.2%** (9/139 eyes)
 - 1 eye, 2 mos post op, haze trauma site
 - 1 eye, traumatic iritis
 - 3 eyes, 2 patients, corneal abrasions from tonopen
- Follicular conjunctivitis: **6.5%** (9/139 eyes)
 - 5 patients, 5 -12 months post-op
- Peripapillary hemorrhage: **0.72%** (1/139 eyes)
 - 5 mos post-op
- Scleritis and/or episcleritis: **2.2%** (3/139 eyes)

ZM

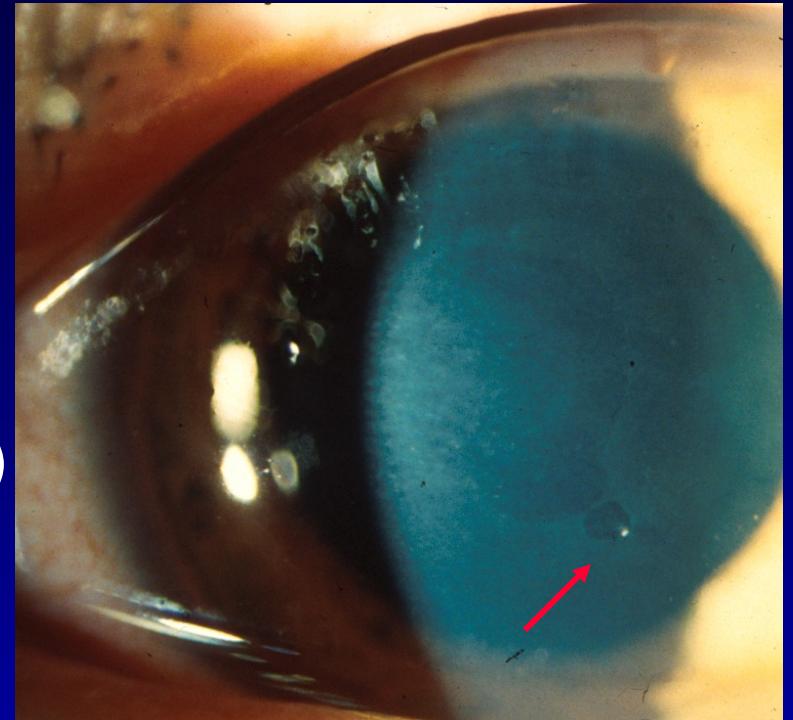
- 24 y/o M
- 6 mos post PRK OU
- Ulcerative follicular conjunctivitis
- Episcleritis
- Peripheral K infiltrates
- Hematuria
- Neck rash
- *Bartonella henselae* 1:64 (+)
- *Bartonella quintana* 1:128 (+)



USAF PRK Study

Additional Procedures

- Debride epithelial flap: **2.2%** (3/139)
- Remove foreign body from under CL: **2.2%** (3/139)
 - Merocel sponge fragment
 - Fiber
 - Thread
- Retreatment: **1.4%** (2/139)



USAF PRK Study SUMMARY

USAF Other

Delayed epithelialization (> 4 days)	0%	2%
Contact lens-related issues	14.1%	?
Immune subepithelial infiltrates	2%	0.3-0.4%
Infectious keratitis	0.7% cases	
Ocular hypertension ($Ta \geq 25$ mm)	14%	0.8-32%*
Haze ($\geq 2+$)	0%	0-6.7%
Late onset corneal haze	6.6% cases	

* $>8-10$ mm elevation

USAF PRK Study SUMMARY

	USAF	Other
Loss \geq 2 lines BCVA (at 12 mos)	0%	0-7%
UCVA < 20/20 (at 12 mos)	24%	0-56%
UCVA < 20/40 (at 12 mos)	0%	0-25%
Under or overcorrection (>1 diopter, 12 mos)	0%	3-28%
Retreatment	1.4%	0-37%